steam dome, into which the steam from the upper part of the boiler enters, its amount being governed by a regulator controlled by a winch. This serves to obviate in great degree the effects of priming. The steam pipe, *e*, has two branches, each entering one of the boxes containing the valves by which the flow of steam to the cylinders is controlled. C is an express engine designed by Gooch for the Great Western Railway, where an unusual rate of speed is maintained. The boiler has 305 tubes, 2 inches in diameter. The cylinders are 18 inches diameter and 24 inches stroke, the driving wheels 8 feet in diameter, the heating surface of the fire box 153 square feet. D is an express engine designed by Crampton. It is adapted for the usual gage.

Fig. 6 is a central longitudinal section of an approved form of American locomotive as made at the Baldwin Locomotive Works, Philadelphia. Fig. 7 is a perspective view. Fig. 8 is a front elevation, one half of which shows a transverse section through the boiler. The engine has four drivers, 60¾ inches in diameter, and a four-wheeled swing bolster truck, and weighs, with water and fuel, about 65,000 lbs. The flues, 144 in number, are 2 inches in diameter, and 11 feet 5 inches in length. The fire box, of cast steel, is 66 inches long, 34½ inches wide, and 63 inches deep. Water space 3 inches sides and back, 4 inches front. Grates, cast iron. The cylinders are horizontal. Valve motion graduated to cut off at any point of the stroke. The tires are cast steel, and the wheel centers of cast iron with hollow spokes and rims, the wrist pins of cast steel, the connecting rods of hammered iron. The truck wheels are 28 inches in diameter. All the principal parts of such engines are interchangeable.

Attempts are being made, by adaptation of the furnace and boiler, to run locomotives by means of liquid fuel. Differences also occur in the construction of the heating parts, according to the character of the fuel—coal, coke, wood, peat, etc.

The ordinary speed attained on English railways is greater than that usual in this country. The Great Western express from London to Exeter travels at the rate of 57 miles an hour including stoppages, or 55 miles an hour while actually running. Midway between some of the stations a speed of 65 miles an hour has been reached. A speed of 75 miles is equivalent to 35 yards per second, so that if a row of stakes one yard apart were driven at the side of the road, they would, at this velocity, appear undistinguishable one from another. Were the driving wheels of the locomotive 7 feet in diameter, they would revolve 5 times in a second, each piston would traverse the cylinder 10 times per second, while there would be 20 discharges of waste steam per second, causing a continuous sound instead of the cough which is heard when the engine is moving slowly.

Very high speeds have been attained, on special occasions, on American roads, probably fully equaling any time ever made in England. For instance, it is stated that a train, conveying some officials of the New York Central Railroad, made the distance from Rochester to Syracuse, 81 miles, in 61 minutes, said to be the fastest time ever made in America.

The life of a locomotive engine is stated, in a paper read before the British Association, at thirty years. Some of the small parts require renewal every six months. The boiler tubes last five years, and the crank axles six years; tires, boilers, and fire boxes, seven to ten years. The side frames, axles, and other parts, thirty years. During this period, the total cost of repairs is estimated at $24,450 in American money, the original cost of the engine being $8,490. It therefore requires for repairs, in eleven years, a sum equal to its original cost. In this time it is estimated that an engine in average use has run 220,000 miles.

Correspondence.

The Sun's Retrograde Motion and the Weather.

To the Editor of the Scientific American:

Some time ago, I showed, in your columns, that both lunar acceleration and retardation in the earth are pure results or outgrowths of increase in the sun's motion; and still later, I showed, through the same channel, that inequality in the moon's mean motion is a result of solar retrograde motion; and now, with your permission, I will show that solar retrograde motion, or the sun's velocity, has much to do with our terrestrial winds and weather.

It is recorded in Harper's *Monthly Magazine* for November, 1876, that Mr. Charles A. Schott, of the Coast Survey Office, has, by great labor and investigation, discovered that there is what we may call an oscillation of the winds and weather in about every seventy years. Says the magazine: "All the stations agree in showing a rapid rise in the temperature about February 20. There are also indications that the hottest and coldest epochs change somewhat from year to year, making a complete circuit in seventy years through a range of about six weeks. On comparing the average direction of the wind with the average temperature, it appears evident that for years of northerly winds the temperature is lower, and for southerly winds it is higher So that secular changes in local temperature are attributable to corresponding changes in the direction of the winds. These latter changes, on the other hand, must be a part of a system of oscillation in the general currents of the atmosphere, which may be ultimately due to slight variation in solar radiation." Here I wish to note three things: first, that the wind and weather are supposed to circulate round the earth in some 70 years; second, that change in the winds may possibly be due to slight variation in solar radiation; and third, that I see, from another printed source, that a certain "German philosopher, Professor Prestel," ascribes weather changes "to the moon." Allow me to present my views.

The sun retrogrades in the plane proper of the ecliptic 50¼ seconds, annually; and so of course does the earth, in her own orbit, as it were; and it takes her 20 minutes and 20 seconds, in other words, 1 year, 20 minutes, and 20 seconds, to reach the same point in the heavens that she was at, say, on December 31 last at 12 o'clock at night. Twenty minutes and twenty seconds amounts to one day, or one rotation of the earth, in 70⅔ years. In 70 years and 8 months, therefore, the earth loses one day on the stars; and it will be seen in a moment or two that she loses the same amount, in the same space of time, on the winds and the weather; for the winds do not circulate round the earth, as supposed, but the earth turns—retrogrades round—to receive the winds, supposing them to blow from the same quarter.

To give a proper idea of what we mean, suppose the sun to be moving retrogressively at great velocity, and the earth in consequence to be ever meeting and stemming an etheric current: suppose too that the earth's rotary motion is stopped, and that nothing but her orbital motion and the sun's is going on. In such a case, the etheric current would ever strike the earth on one point of her surface; that would be the point or side of her that is ever lying next to the current. Now suppose that she retrogrades round her axis in a year, an amount equal to the 1-365¼ of a rotation—an amount equal to 20 minutes and 20 seconds—the point on her surface that directly breasted, so to speak, the etheric breeze last year would not breast it this year; but one, a little more than 5° east from it, would. Thus, by the earth's westerly or retrograde motion, as it were round her axis, the ever parallel current of storm seems, to all appearance and to meteorological evidence, to circulate easterly round the earth, while in reality it is the earth that is turning round to receive the ever parallel-flowing etheric breeze: a current that must ever flow directly from the sun as radiance, or be the result of the earth's being drawn, as it were, through ether by virtue of the sun's velocity, as a vessel propelled through water meets the still water as if it were flowing in a current against it. This, I say, would give the winds and weather an apparent easterly motion round the earth in some seventy years: and that is exactly as Mr. Schott finds it. I cite again from Harper's *Magazine*:

"Mr. Schott finds no perceptible secular change in the temperature of the country, nor any decided connection between our temperature and the variations in solar spots. For ten stations the mean temperature has been commuted for every day of the year, and it appears from these that changes in the normal temperature of any day extend over large tracks of country, and progress in an easterly direction." Thus I connect even the winds and the weather with solar retrograde motion, and I think that the moon has nothing to do with the weather. She, in every 18 years, and all along through the 19th year, so conjoins with the sun and earth that the four—sun, earth, moon, and storm current—are in line, or parallel with each other, and so a sort of periodic 19 years storm occurs. But the moon has no more to do with raising it than the surface of the earth has with the so-called seventy years oscillation, that is, the seventy years and eight months oscillation.

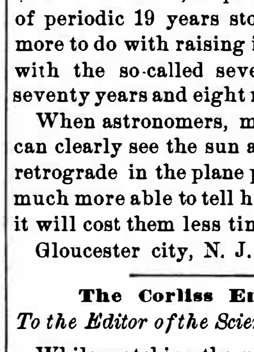
When astronomers, meteorologists, and other scientists, can clearly see the sun and the whole solar system moving retrograde in the plane proper of the ecliptic, they will be much more able to tell how and why phenomena occur; and it will cost them less time and labor too, I think.

Gloucester city, N. J. JOHN HEPBURN.

The Corliss Engine at the Centennial.

To the Editor of the Scientific American:

While watching the movements of this celebrated engine a few days ago, I noticed among its details two improvements upon former engines of the Corliss style. The most important of these consists in the placing of the valves in the heads of the cylinder instead of in the cylinder casting. This disposition of the valves does away with the eight triangular cavities in each cylinder which form the steam ports, namely, A, the inlet, B, the exhaust ports. The diagram shows a cross section at one end of a cylinder through the center of the ports, the aggregate capacity of these ports being equal to from two to four per cent of the steam used in working the engine. By placing the valves in the heads of the cylinder, they are brought almost in contact with the piston (when at the end of its stroke) from end to end of the ports, thus effecting a saving of the two or four per cent of steam usually wasted, and of course enhancing the economy of the engine in like proportion.



Could a like improvement be made in the valve gear of locomotives, the consequent saving of fuel ought to give the inventor a fortune in a short time. In locomotives, from five to ten per cent of the steam used is wasted in the huge passages between the valve and piston: and more, another benefit (aside from the direct saving of from five to ten per cent of steam, owing to the more perfect appropriation of the steam used, consequent upon the close proximity of the valves to the piston) is lost. Some engineers argue that short steam ports are of but little benefit in any case, especially in engines working under a high degree of expansion. By what line of sophistry they arrive at such a conclusion, I know not. They might, by the same reasoning, say that an engine would work just as economically with steam passages long enough to contain half of the steam used. It makes no difference whether the steam is exhausted from the cylinder at 90 or at 5 lbs. pressure to the inch; the percentage of waste will be precisely the same. The cubic capacity of the steam passages between the valve and the bore of the cylinder represents exactly the cubic quantity of steam used over and above what is needed to work the engine; and the sooner locomotive builders realize this, the sooner they will be prepared to reduce the length of these wasteful passages.

Another improvement noted in this engine consists in the interposition of a short link between the rocker arm and the arm upon the valve stem, in such a way as to cause the valve to open and close quickly, and to remain open and almost stationary for a considerable interval, thus giving a very free exhaust and a timely and rapid opening and closing of the valves. F. G. WOODWARD.

Worcester, Mass.

The Bude Canal in Cornwall, England.

To the Editor of the Scientific American:

The Bude Canal, from Bude to Launceston, is said to have been working for fifty years. It was intended to transport ore from Launceston to Bude, but is now principally used to carry coal, and sand from the coast for manure for the farms. In order to carry the canal over the highest points of the land, a very simple and wonderfully effective plan has been carried out. The canal is made in sections, each on a level; and each two sections are joined by an inclined plane, on which are laid grooved rails. The barges, which are built for the purpose, are hauled bodily out of the canal laden with, say, 4 tuns of coal or sand, and drawn up the tramway with a chain, and launched again in the next section of canal, which starts from the top of the hill. There are in the entire length of the canal six of these planes, three between Bude to the highest point, and three down into Launceston. At Marham, about 1½ miles up the canal from Bude, is the first ascent. I judged the length of the incline to be 800 feet, and the gradient 1 in 6; the total ascent, therefore, is about 130 feet. The barges are small, of about 5 feet beam, and 15 feet in length, and are loaded with 4 tuns, total weight being 5 tuns each when loaded. Fitted on the flat bottoms are four wheels, which run in the grooved rails, laid like an ordinary tramway, in two lines up the incline. An endless cable passes between the rails, up one and down the other, and round large wheels at either end. These wheels are fixed horizontally. The wheel of the upper end has a strong shaft or axis, which descends into a chamber below, where, by means of cogged wheels, it is connected with an enormous water wheel, the moving power. This water wheel is overshot, and has a diameter of 60 feet. The barge to be hauled up having been placed in position and fastened to the endless cable chain, the water wheel is set in motion, and the barge is rapidly drawn to the top of the incline and floated again in the upper canal. About two miles further up I came to Hobbacott, where is the second incline. This is longer and steeper, and is worked in a different manner. This incline is 900 feet long; total rise, 275 feet. At the top are two wells, 20 feet in diameter and 225 feet deep. At the bottom of each is an escape for water to flow out into the lower canal. Suspended in these wells, by massive cables from a horizontal roller, are two huge iron buckets, capable of holding 60 hogsheads of water each, and weighing, when full, 16 tuns. These are so arranged that, when one bucket is at the top of one well, the other bucket is at the bottom of the other. The bucket which is at the top of the well is filled with water from a sluice, and is allowed to descend; and in doing so, it raises the bucket in the other well, which comes up empty, the water having escaped through a valve which opened mechanically when the bucket reached the bottom. The alternate rising and falling of these buckets sets in motion the endless chain cable on the incline; and by means of cogged wheels, the power is so mul iplied that the descent of the bucket, weighing 16 tuns, into the well 225 feet deep, suffices to haul a barge weighing 5 tuns up the entire length of the incline, 900 feet, in the space of 4½ minutes. The whole of this machinery is worked by two men and a boy, with no further expense than the oil for the machine.

About nine miles further up the canal, at its highest point, is a vast reservoir measuring 60 acres, which supplies the water for working the canal.

London, England. B. R. PLANTE.

The Supposed Planet Vulcan.

To the Editor of the Scientific American:

Please to add my testimony to that of others regarding the intra-mercurial planet. Unfortunately, when I saw the planet, supposing it to be known to astronomers, I did not attach such importance to the subject as to induce me to make memoranda, and at this distance of time can only think that it was about the year 1860. I was residing then in Washington Territory, and was superintending some work on a prairie, a few miles from Fort Vancouver, on the Columbia River. A range of mountains was in the distance, from behind which the sun had reached an altitude of about 30° above the horizon, when a small boy asked me what was the matter with the sun. On looking at it I saw a planet, not as your correspondent saw it, but as a perfectly rounded, well defined dark spot, having with the disk a smaller relative proportion than that you have illustrated, and situated nearer the disk's diameter. I watched its progress till its completion without a telescope, merely glancing with partially closed eyes, at very short intervals. It was in the hight of summer, and the hour was so early that no one but our party, that I have heard of, saw it. I am sorry I can give so few data regarding an event of which I am as certain as of my own existence. The clear but peculiar skies of that region in summer may account for the distinctness of the view.

Washington, D.C. RICHARD COVINGTON.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

SECOND SERIES—Number XV.

PATTERN MAKING.

Our second example, Fig. 106, is a design for another kind of gland. such as is often fitted to glands for pump rods and spindles. For the small sizes, the glands are usually cast

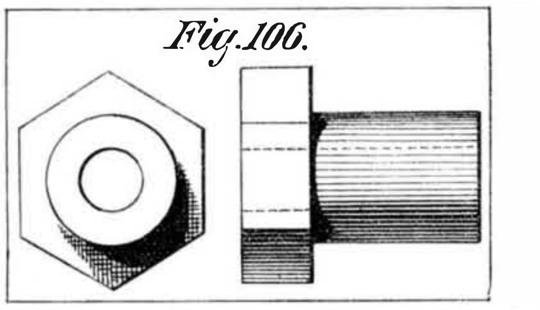


Fig. 106.

solid, and the hole is drilled out in the lathe, in which case, providing the gland is not very deep, it would be molded vertically, with the head in the nowel, and would be turned out of the solid piece of wood in the style of our previous example, treating for the moment the hexagonal part as a flange, whose diameter must be turned to the size of the hexagon across the corners. After the turning is done, we mark the hexagon as follows. We set a pair of compasses as nearly as possible to the radius of the turned piece that is to form the hexagon, and divide that piece off into six divisions, in the manner shown in Fig. 107; for the radius of a circle will divide its circumference into six equal parts. So that, if the compasses are correctly set, one trial will be sufficient; but if not, we must readjust the compasses and go around again. Then, from these points, we square lines. as shown in Fig. 107, at 1, 2, 3, 4, 5, 6; and then, with the paring

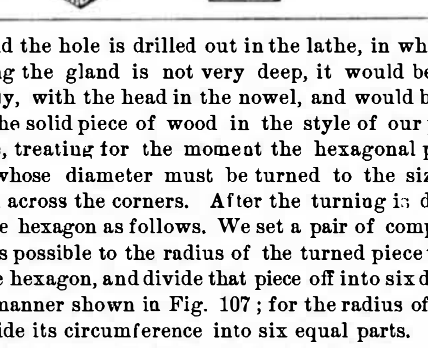


Fig. 107.

chisel, we pare off the sides to the lines. It is not necessary to actually draw the hexagon on the circumference by joining the lines of division on the top of the flange; for a straight edge, being applied as the paring proceeds, will be all that is necessary to produce a true hexagon. Nevertheless it is possible that error may have crept in, though we have performed the above operation with the greatest of care; it is therefore imperative upon us to apply correcting tests to our work, such as a pair of calipers to try if each pair of the opposite sides are parallel, also the bevel to verify if each angle of the figure contains 120°. Hexagon shapes are so common that a special hexagon gage is very useful; and such a gage, of the most approved form, is shown in Fig. 108, together with its method of application, the edges, A B, being to try the hexagon, and C D to square

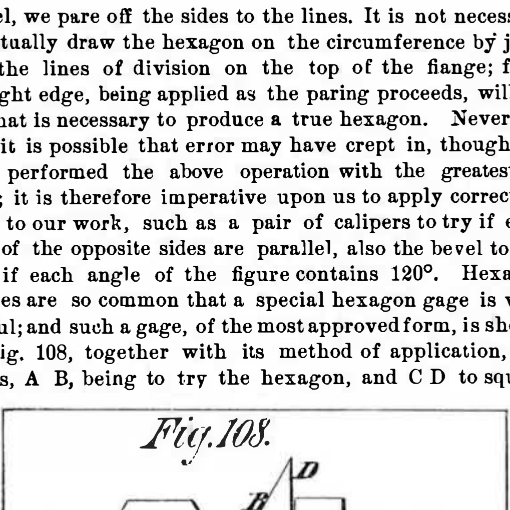


Fig. 108.

the edge to the face, and the edge, E, being used as a straight edge. If, however, we have not such a gage, we may set the bevel square, shown in Fig. 23, in the following manner: Take a piece of board planed on one side and on one edge, and let A B, in Fig. 109, represent the planed edge, from which we mark with the gage the line, C D. Then taking any point, such as I, in the line, C D, as a center, at a convenient distance we describe with a pair of compasses the arc, F G. We then take the compasses, and, without shifting their points at all, we rest one point on the intersection of the lines, C D and F G, and then mark the arc, H. If then we draw a line from the intersection of the arc, F G, and the arc, H, to the center, I, upon which the arc, F G, has struck, the lines, H I, I C, form the angle required; and we may apply the stock of the bevel square to the planed edge, A B, and set the blade to the line, I H, as denoted by the dotted lines. The bevel being set, we test the work as it proceeds, first cutting down one hexagonal side and then applying the bevel to gage the angle of the others; and as the diametrically opposite sides are finished, we apply the calipers. The lines of division upon all good pattern work are made very fine, in fact merely distinguishable; and the instrument by which they are drawn is shown

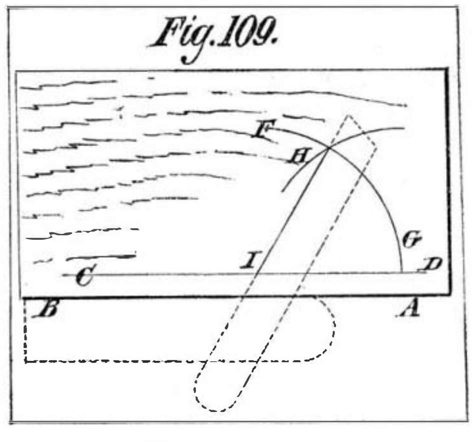


Fig. 109.

in Fig. 110. It is called a cutting scriber, and the end at A is beveled off at both sides, like a skew chisel, forming a knife edge. The end, B, is ground to a point, and both ends

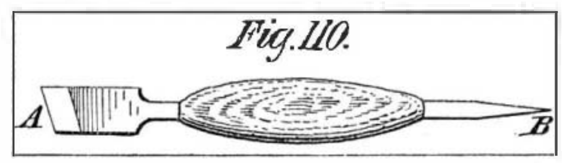


Fig. 110.

are finished on an oilstone. The point end is for drawing lines along the grain, while the cutting edge, A, is for drawing lines across the grain of the wood. The wooden handle in the center is to enable the operator to hold it more firmly. It sometimes happens that the size of the hexagon is given across the flat sides instead of over the angle; and when that is so, we proceed as follows: We describe upon a piece of board, as in Fig. 111, a circle of a diameter equal to the given distance between the flat sides. We then take a hexagon gage, or else set the bevel square to an angle of 120°: and applying it to the planed edge of the board, we draw the line, C D, in Fig. 111, in which figure, A is the circle of the size of the flat sides of the hexagon, and B E are the planed edges of the board. We next reverse the bevel; and from the opposite edge of the board we strike the line, F D, cutting C D at the point, D, where both the lines cut the circumference of the circle, A. Then from the center of the circle, A, we draw the circle, G, intersecting the point, D. The diameter of G will be the size of the hexagon across the corners.

If the gland is a long one, it will be better to make it in

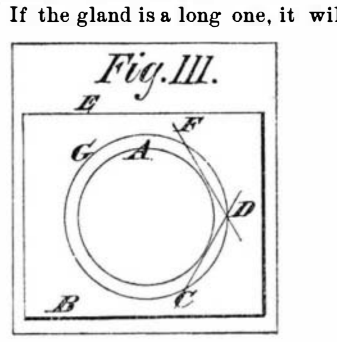


Fig. 111.

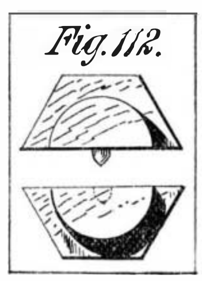


Fig. 112.

halves, letting it part across two corners, as shown in Fig. 112. When a gland of this kind is made in halves, the corners at the parting are liable, from their weakness, to chip off, and it is therefore proper to make it of hard wood.

Water Supply for Towns.

The subject of water supply is one that is now engaging the attention of the authorities in many large towns. The extended drought in the Eastern States during the past summer has revived in this vicinity the enquiry for advice as to the best means of providing an inexhaustible supply of water.

The city of Orange, N. J., and the adjoining town of Montclair, both rapidly growing places, have during the past summer been exceedingly short of water, to the inconvenience of many of the citizens. Montclair lies at the foot of Orange Mountain, and the city of Orange scarcely one mile from the base of the same mountain, on which inexhaustible springs are found by digging only a few feet. It occurs to us that the above places, as well as many other towns, similarly situated in the vicinity of mountains, might readily be supplied in the manner in which the city of Dubuque, Iowa, has recently (by accident) acquired a novel and practical water system. Sometime ago, in one of the bluffs, a lead-mining company met obstruction from water; and to obtain relief the bluff was tunneled, when it was found that a copious fountain had been struck, which ran to waste for several years. But the water was most excellent, the supply exceedingly liberal, and the head so elevated that the idea of utilizing it was seized by a company, the property purchased, and a system perfected which gives the cheapest and best water supply known in the country.

Origin of Wire Rope.

Mr. Andrew Smith, C. E., of London, in the year 1828, first applied wire rope as a substitute for catgut, in aid of another invention of his for metallic shutters. The rats have destroyed the strength of the catgut line by eating it; the position of the sheave or pulley was so placed and so narrow in the groove that none but a small substance could be applied to that particular case. Necessity, after all, was the mother of invention. Time rolled on, and the author watched anxiously the working of this experimental metallic cord; four years were spent in experimenting, in order to test its strength in comparison with hempen rope and chain, as regarded weight, size, strength, price, durability, and economy. This required time, patience, and a heavy outlay of capital. On January 12, 1835, the first patent was obtained by Mr. Smith, and in 1839 he had obtained his fourth patent.

Stick to a Legitimate Business.

Well directed energy and enterprise are the life of American progress; but if there is one lesson taught more plainly than others by the great failures of late, it is that safety lies in sticking to a legitimate business. No man—manufacturer, trader, or banker—has any moral right to be so energetic and enterprising as to take from his legitimate business the capital which it requires to meet any emergency.

Apologies are sometimes made, for firms who have failed, by recurring to the important experiments they have aided, and the unnumbered fields of enterprise where they have freely scattered their money. We are told that individual losses sustained by those failures will be as nothing compared with the benefits conferred on the community by their liberality in contributing to every public work. There is little force in such reasoning. A man's relations to a creditor are vastly different from his relations to what is called the public. The demands of the one are definite, the claims of the other are just what the ambition of the man may make them.

The histories of honorably successful business men unite to exalt the importance of sticking to a legitimate business; and it is most instructive to see that, in the greater portion of the failures, the real cause of disaster was the branching out beyond a legitimate business, in the taking hold of this and that tempting offer, and, for the sake of some great gain, venturing where they did not know the ground, and could not know the pitfall.

The Inventor of Gas Lights.

The inventor of gas lights is said to have been a Frenchman, Philippe Le Bon, an engineer of roads and bridges, who in 1782 adopted the idea of using, for the purpose of illumination, the gases distilled during the combustion of wood. He labored for a long time in the attempt to perfect his crude invention, and it was not until 1799 that he confided his discovery to the Institute. In September, 1800, he took out a patent, and in 1801 he published a memoir containing the result of his researches. Le Bon commenced by distilling wood, in order to obtain from it gas, oil, pitch, and pyroligneous acid; but his work indicated the possibility of obtaining gas by distillation from fatty or oily substances. From 1799 to 1802, Le Bon made numerous experiments. He established at Havre his first thermo-lamps; but the gas which he obtained, being a mixture of carburetted hydrogen and oxide of carbon, and but imperfectly freed from its impurities, gave only a feeble light and involved an insupportable odor, and the result was that but little favor was shown to the new discovery; the inventor eventually died, ruined by his experiments. The English soon put in practice the crude ideas of Le Bon In 1804, one Winsor patented and claimed the credit of inventing the process of lighting by gas; in 1805 several shops in Birmingham were illuminated by gas manufactured by the process of Winsor and Murdock: among those who used this new light was Watt, the inventor of the steam engine. In 1816 the first use was made of gas in London, and it was not until 1818 that this invention, really of French origin, was applied in France.

How the Centennial Revives Business.

Much has been said by the press throughout the country about the visitors to the Centennial, and the advantages to be derived by the Exhibition. But the *American Builder* advances an idea which we have not seen alluded to elsewhere:

Every merchant and most well-to-do farmers and mechanics have visited some one of our large cities. But never before did they bring their wives and daughters. This last is the marked feature of the travel this year. For the first time, in a number of cases, the wife, mother, and daughters have passed the borders of their native States. To them the crowded car, the well lighted hotel, the thronged streets, the new customs, are a revelation. They will carry back to their homes new wants and desires. Insensibly, perhaps, there will be a change in household and personal habits. The furniture of the parlor and sleeping room will have additions and changes. Clothing once esteemed as tasteful will be replaced by other styles, not more expensive, but of different shades and shapes. The mechanic or the farmer will have new and enlarged ideas of his power as a part of our political and economical forces. This increased knowledge is one of the principal reasons why such expositions are encouraged; and it is to play no unimportant part in the present marked revival of business activity.

TO electrotype insects, ferns, etc., immerse the object in a solution of nitrate of silver in wood naphtha. When partially dried, the object should be treated with ammonia, the result being a double salt easily reduced. After thorough drying, expose the article to the vapor of mercury, when the surface becomes completely metallized in a few minutes. It may then be placed in the bath and metal deposited in the usual way.

BRASS cooking pans should be cleaned inside with vinegar and brick, then rinsed, thoroughly dried at the fire, and wiped with a clean cloth. White enameled pans require only a little soda and warm water to keep them clean and free from grease.